Agent and Multi-Entity Systems Modeling

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Abstract

This paper describes a method for studying the functional and temporal performance of systems controlled by distributed autonomous agents through simulation of the agents within larger systems.

There are many challenges to developing successful agent systems. Although there are multiple agent architectures or approaches for a given application, it is difficult to predict which is best. The behavior of complex distributed autonomous agent communities is notoriously difficult to predict or certify prior to the final implementation of an approach. Agent architecture development is quickly burdened with implementation details before major questions are answered, such as:

- stability, - convergence, - negotiation logic
- efficiency, - robustness, - agent architecture
- speed, - resilience, - agent class structure

New capabilities are needed to predict and analyze agent architectures early, prior-to and throughout detailed development. It will assist in guiding optimization, and simplification of implementations. It can provide quick "what-if" analysis.

A comprehensive, flexible agent modeling technique is needed which must model the outer systems that agents operate within, and which must resolve functional, temporal, and spatial aspects. Ideally, there should be an automated flow from modeling and development to fielded systems. Such capability would Support early demonstration, to incorporate feedback from users within time to accept it.

A brief survey of previous agent simulation environments is presented, covering such tools as U. New Mexico - SWARM, and Brookings Institute/Nutech - Ascape, U. Chicago - Repast.

Finally, an initial experimental model with two scenarios is described to add some concreteness to the discussion by example. A hierarchical agent-based simulation environment called ATL-CSIMis introduced. The modeling work done with this tool demonstrates agent operations within larger systems while revealing timing performance/response and assessing functional quality of the collective agent solutions. The preliminary results show emergent multiple-level hierarchical organization. The first scenario involves agent navigation in a two dimensional space with a series of progressive challenges provided by a mixture of agent roles. The second scenario operates in a text-based mathematical equation space for a non-linear dynamic system. The two distinctly differing scenarios were chosen to demonstrate the generality of the approach, and to show that it can be applied to many domains. The work is contrasted with the previous efforts.

References:

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